

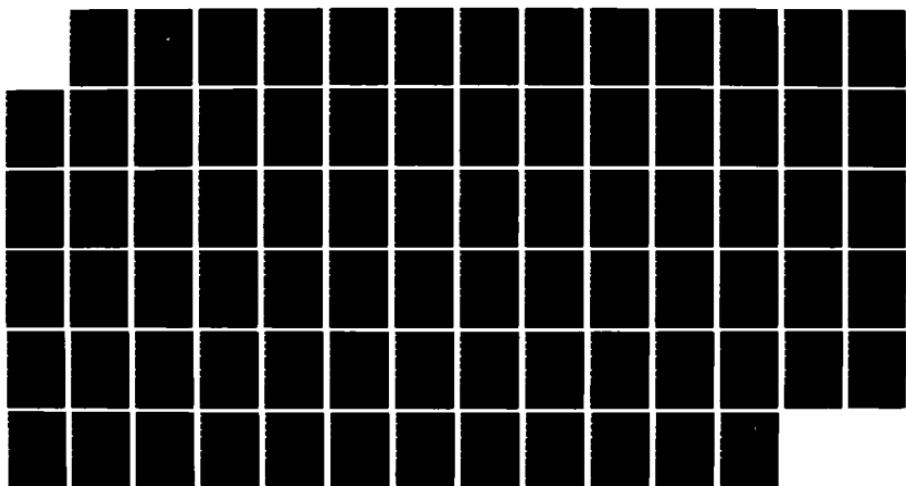
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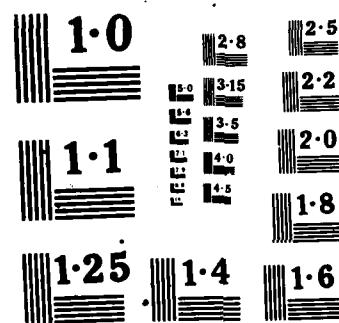
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THESIS

POLITICAL CONSIDERATIONS IN DEVELOPING
MEASURES OF EFFECTIVENESS
FOR STRATEGIC DEFENSE

Robert J. Cerwonka

March 1986

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Thesis Advisor:

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Political Considerations in Developing
Measures of Effectiveness
for Strategic Defense

by

Robert J. Cerwonka
Lieutenant, United States Navy
B.S., Pennsylvania State University, 1979

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF ARTS IN NATIONAL SECURITY AFFAIRS

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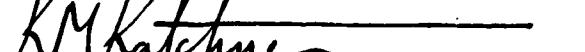
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ABSTRACT

This thesis develops a Measure of Effectiveness (MOE) for strategic defenses from open source political literature. First, an examination of the doctrines and strategic nuclear force structures of the United States and the Soviet Union is conducted to illuminate the primary challenges to a U.S. system of strategic defense. Second, the issue of utilizing strategic defense for the protection of U.S. retaliatory nuclear forces (counterforce enhancement) is addressed. Third, the degree of effectiveness which a counterforce enhancing system of strategic defense must meet is established through the definition of minimal retaliatory assets required to effect U.S. targeting plans. Finally, the conclusions and findings of this research are presented in a summary chapter.

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I. INTRODUCTION

A. BACKGROUND

On March 23 1983 President Ronald Reagan astonished a national audience with the pronouncement of a new stratagem for national nuclear defense fundamentally removed from the "established" posture of deterrence through the doctrine of mutually assured destruction (MAD). In brief, the Chief Executive's televised address heralded the genesis of the Strategic Defense Initiative (SDI), a program conceived in part to synthesize the scientific and technological resources of the United States in a coherent effort to analyze the practicability of integrating strategic defenses with U.S. nuclear policy. The ultimate goal of this effort would be the rendering of nuclear weaponry "impotent and obsolete." [Ref. 1]

Initial reaction to the so-called "Star Wars" speech was both critical as well as supportive, and the past three years have not witnessed a lessening in the intensity of debate on the merits of the Presidential proposal. To paraphrase the late Herman Kahn, it would appear that four fundamental schools of thought have developed within political, defense and intellectual circles regarding the issue of strategic defenses: There are those who enthusiastically support the proposal, those who vehemently oppose the proposal, those who remain largely uncommitted on the issue and those who remain uninformed on the topic.

This thesis does not purport to analyze in depth the foundations of the arguments proffered by each camp. Rather, it attempts to develop a Measure of Effectiveness (MOE) for a system of strategic defense from open source political literature.

B. MEASURES OF EFFECTIVENESS

A quantitative measure used to compare the effectiveness of alternatives in achieving a given objective is called a Measure of Effectiveness (MOE) [Ref. 2: p. 13]. In other words, an MOE may be construed as an index by which performance towards the achievement of a given goal or objective may be gauged. Measures of Performance (MOP), Figure of Merit (FOM), operational effectiveness, and utility are frequently used interchangeably and synonymously with the term Measure of Effectiveness [Ref. 3: p. 2]. To be valid, an MOE must be closely related to the objective of the operation in question and must be measurable and quantifiable. Mathematically, a MOE may be represented by the equation

$$(x^*) = \arg \text{MAX}_x F_X(x). \quad (\text{eqn 1.1})$$

Here, $F(x)$ represents a mathematical model for the system under study; (x^*) represents the optimal solution (in this case scalar) subject to real-world constraints [Ref. 3: p. 4].

From a less mathematically oriented position, however, Naval Operations Analysis provides succinct guidelines for users of MOE methodology [Ref. 2: p. 13]. First, the MOE must be closely related to the objective or goal of the operation. Second, it must be measurable and quantifiable. Finally, it must measure to what degree the objective is achieved.

C. RESEARCH OBJECTIVES

This thesis will conduct a detailed analysis of the following areas in an effort to define an objective function suitable for the methodology of MOEs with respect to strategic defenses. First, an examination of the doctrines and strategic nuclear force structures of the United States and the Soviet Union is conducted to illuminate the primary

challenges to a U.S. system of strategic defense. Second, the issue of utilizing strategic defenses for the protection of U.S. retaliatory nuclear forces (counterforce enhancement) is addressed. Third, the degree of effectiveness which a counterforce enhancing system of strategic defense must meet is established through the definition of minimal retaliatory assets required to effect U.S. targeting plans. Finally, the conclusions and findings of this research are presented in a summary chapter.

II. STRATEGIC DOCTRINES AND FORCE STRUCTURES

A. U. S. DECLARATORY DOCTRINE

A working knowledge of the strategic objectives of both the United States and the Soviet Union is critical in assessing the viability of strategic options designed to fulfill the objectives of both superpowers in a nuclear exchange. After all, doctrinal considerations are influential in the acquisition of strategic forces and the development of employment policies. Accordingly, this chapter begins with an examination of the declaratory strategic doctrine of the United States.

The fundamental, and according to Slocombe [Ref. 4: p. 611], "unchanged" strategic objective of the United States is the deterrence of aggression that could possibly lead to a nuclear confrontation. Official policy statements by government officials and the political literature of the defense intellectual community uniformly correspond with Slocombe's recognition of deterrence as the conceptual cornerstone of United States strategic doctrine. What is not universally acknowledged, however, is the precise mechanism (if one indeed exists) through which the United States transforms the abstractions of deterrence theory into palpable strategic doctrine and policy.

Gray [Ref. 5: p. 2] identifies the three schools of deterrent thought that permeate U.S. doctrinal and policy debates. The first perspective, that of "Societal Punishment," maintains that Soviet aggression is deterred through the prospect of massive societal punishment inflicted by the retaliatory strategic nuclear forces (SNF) of the United States. An alternative viewpoint is offered by the second school, which alludes that the U.S.S.R. is deterred when confronted by credible threats focused on the

highest of official (not necessarily societal) Soviet values and interests. Advocates of this orientation, known as the "Countervailing Strategy," suggest that the United States effectively deters its adversary by threatening to thwart Soviet strategy (i.e., denying the Soviets "victory") by forcefully eliminating the war-waging capabilities of the Soviet state. Proponents of the third school, that of the "Prevailing Strategy," assert that the U.S.S.R. is deterred when the United States is able to impose military defeat on the Soviets while simultaneously securing the achievement of Western political goals and objectives.

A brief review of Gray's description of these three basic schools of deterrent thought should illuminate the fundamental dissimilarities and commonalities among them. Arrival at this sort of conclusion is intuitively correct, as there are obvious differences between an approach which advocates extensive human punishment on one hand (a "countervalue" strategy), the thwarting of war aims on another (a "counterforce" strategy), or the imposition of victory on yet another (a "counterforce-plus" strategy). Arrival at this conclusion is also supported by the historical record and is best substantiated through an analysis of the Anti-Ballistic Missile (ABM) policy debates of the late 1960's [Ref. 6]. The direct outcome of these debates (U.S. advocacy and establishment of a treaty limiting the deployment of ABM systems by both superpowers) represents a decidedly clear victory for the societal punishment school of strategic thought [Ref. 7: p.215]. Yet each school allows for flexibility in strategic targeting, as well as compatibility with U.S. force planning requirements to enhance the viability of its position [Ref. 5: p.3]. Of significance to this thesis, however, is the correct identification of the deterrent school of thought which exerts the dominant influence on current U.S. strategic nuclear doctrine and force planning.

Payne notes that the paradigm of "mutual vulnerability" associated with the societal punishment or "assured vulnerability" school of deterrent thought has dominated strategic theorizing in the U.S. defense community [Ref. 7: p. 215]. This observation is accurate in correctly identifying the intellectual perceptions of most analysts in the defense community regarding the nature of U.S. nuclear strategy. It is somewhat erroneous, however, as a reflection of the realities of U.S. strategic nuclear doctrine.

The inadequacy of mutual assured vulnerability as a legitimate paradigm for deterrence stems from a basic observation of the current U.S.-Soviet relationship: mutual assured vulnerability is neither mutual nor assured. In the first place, a substantial quantity of evidence exists in the military and political literature of both superpowers supporting the thesis that the Soviets do not regard mutual assured vulnerability as a two-sided relationship. Secondly, a valid argument may be made to the effect that this particular paradigm is not necessarily assured in nature. This is especially noticeable when an evaluation of the military utility of U.S. SNF is conducted following a preemptive counterforce first strike. These two points will be examined in further detail in this and subsequent chapters of this thesis.

Friedberg [Ref. 8: pp. 566-568] argues that extensive adherence to the doctrine of assured vulnerability (or "mutual vulnerability") by many strategic analysts is the direct result of historical and conceptual confusion. Historical confusion, according to Friedberg, arises from limited (if any) public access to highly classified nuclear war planning documents; conceptual confusion is produced by imprecisions in strategic language, with the incorrect usage of the word "doctrine" cited as a classic example.

Due to the unclassified nature of this thesis, it would be difficult to dispense entirely with historical confusion and its accompanying influence on doctrinal analysis. Nonetheless, it is reasonable to conclude that a close approximation of actual U.S. strategic doctrine may be constructed through a careful examination of unclassified policy statements by high-level U.S. government officials and other authoritative political literature. Conceptual confusion, on the other hand, may be negated simplistically with the following reasoning.

Ermarth defines "strategic doctrine" as "a set of operative beliefs, values and assertions that in a significant way guide official behavior with respect to strategic research and development, weapons selection, deployment of forces, operational plans, arms control, etc." [Ref. 9: p.596] If this definition remains fundamental to strategic planning in the U.S., then Friedberg's assertion that

an astute analyst would expect to find a 'strategy' which called only for massive retaliatory nuclear strikes against enemy cities, a force posture capable of executing such attacks but suitable for little else, a selection of weapons and an R & D process which reflected a complete lack of interest in defensive systems or offensive forces intended for countermilitary missions, and arms control and declaratory policies which stressed stability, equality, and the importance of mutual vulnerability, [Ref. 8: p.568]

is very difficult to refute and serves to illuminate the fundamental conceptual error inherent in the assured vulnerability paradigm. In other words, Friedberg suggests that a methodology which first reviews official policy statements regarding American strategic doctrine and second examines the structure of the nuclear assets of the United States armed forces will indicate that the widespread acceptance of assured vulnerability as a deterrent mechanism by defense intellectuals is erroneous.

Consider then, the following excerpt from Defense Secretary Caspar Weinberger's Fiscal Year 1986 Annual Report commenting on the utility of a deterrent nuclear strategy predicated on the concept of assured vulnerability:

By 1961, Soviet nuclear capabilities had grown to the point that the inflexible U.S. strategy of massive retaliation was no longer credible. Consequently, the Kennedy Administration formulated a strategy of flexible response that combined a wide range of conventional and nuclear capabilities to enforce deterrence. Today, some 24 years later, U.S. policy remains one of deterrence through flexible response. To be sure, the Soviet threat has evolved, so too has our strategy of flexible response. Additional response options and capabilities were built into our nuclear plans and our forces in order to maintain deterrence in the face of Soviet developments. Each of the changes under succeeding administrations had been designed to ensure that the United States possesses the capability to meet aggression at any level an adversary might contemplate--and thus prevent it (emphasis added). [Ref. 10: p. 46]

This statement suggests that the declaratory nuclear policy of the United States has and continues to reject advocacy of uninhibited retaliatory nuclear strikes against a predominately countervalue Soviet target set as a viable strategic option.

Additionally, the possibility of a failure of the deterrent mechanism implemented by U.S. doctrine and posture is acknowledged in the Annual Report, as is the inherent difficulty in predicting the escalatory pattern of a conflict between the United States and the Soviet Union. Secretary Weinberger does, however, codify the fundamental objective of U.S. strategy in this circumstance:

Should deterrence fail, U.S. strategy seeks the earliest termination of conflict on terms favorable to the United States, its allies, and its national security objectives. Favorable means that if war is forced upon us, we must win--we cannot allow aggression to benefit the aggressor. It does not mean more territory or other powers for the United States. In seeking the earliest termination of the conflict, the United States not only would act to defeat the aggression but would try to convince the attacker to halt his advance because his continued aggression would entail grave risks to his own interests (emphasis added). [Ref. 10: p. 27]

Three distinct conclusions may be derived from analysis of the preceding statements. First, the fundamental structure of United States nuclear doctrine has exhibited remarkable stability over a period exceeding two decades, irrespective of incumbent administrations. This stability is evinced by policy statements which consistently reflect the thwarting of Soviet war objectives through a strategy of denial across the spectrum of conflict as a fundamental principle. The stated objective of restoring the "status quo ante bellum" should deterrence fail is diametrically opposed to the indiscriminate countervalue targeting associated with the societal punishment school of deterrent thought. Second, there is every reason to expect this continuity to extend to the immediately foreseeable future, as Gray and Payne have suggested [Ref. 5,7: pp.3,205-206]. Third, it is reasonable to suggest that the paradigm correctly describing U.S. strategic nuclear doctrine is the "countervailing strategy."

First officially outlined in the 1979 Annual Report of Defense Secretary Harold Brown, the doctrine of "countervallance" represented the culmination of an 18 month review of U.S. defense policies initiated by President Jimmy Carter in the summer of 1977. On July 25 1980, President Carter signed Presidential Directive Number 59 (PD-59), an implementing directive which codified the doctrine and provided further guidance in the realms of strategic targeting and weapons systems acquisitions.

Slocombe provides a succinct description of the basic elements of the doctrine set forth in PD-59:

Under the countervailing strategy, as before, the fundamental U.S. objective is and remains deterrence--but not just of massive attacks on U.S. cities. The United States needs to consider also how to make U.S. nuclear power contribute to deterrence of less than all-out attacks, and particularly how to disabuse Soviets of the belief that a large-scale but still limited aggression, e.g., an attack on U.S. ICBMs or an attack on Europe, could work to their advantage. More generally, the

United States needs to have forces and plans capable of convincing the Soviet leadership that in reality they could not win a nuclear war--whether or not they believe that such wars are in theory winnable by those who have on their side the alleged historical inevitability of the triumph of socialism (emphasis added). [Ref. 4: p. 613]

He further notes that the countervailing strategy does not represent a new doctrine nor a fundamental departure from previous U.S. strategic policies but rather an "evolutionary refinement" of previously established strategic concepts [Ref. 4: p. 615].

The "evolutionary refinement" of strategic principles which Slocombe refers to continues to this day. Consider the following excerpt from Defense Secretary Caspar Weinberger's Fiscal Year 1987 Annual Report:

We do not, in fact, plan our retaliatory options to maximize Soviet casualties or to attack deliberately the Soviet population. Indeed, we believe such a doctrine would be neither moral nor prudent. It is not moral because the Soviet people should not deliberately be made the victims of any U.S. retaliation to an attack launched by the Soviet leadership. It is not prudent because secure deterrence should be based on the threat to destroy what the Soviet leadership values most highly: itself, its military power and political control process, and its industrial ability to wage war. The United States government knows that a nuclear war cannot be won. Our nuclear doctrine is designed to ensure that the Soviet Union's leadership also believes that a nuclear war can never be won--however, they define victory--and, therefore, must never be fought (emphasis added). [Ref. II: p. 75]

It is clear, then, that analysis of recent and current official statements regarding the fundamental nature of United States nuclear doctrine and policy support Friedberg's assertion that the U.S. does not adhere to a strategy of assured vulnerability predicated on the ability to affect massive societal punishment [Ref. 8: p. 568]. Furthermore, U.S. declaratory policy has and remains remarkably consistent with Slocombe's description of the fundamental deterrent objectives of the countervailing strategy codified by PD-59 [Ref. 4: pp. 613-614].

Correlating official policy statements with the theoretical prescriptions of a countervailing strategy is by itself insufficient in establishing actual U.S. doctrine and policy, however. Because effective deterrence is achieved through a credibility derived from "visible, effective, and employable military capabilities," it is also necessary to conduct an examination of the composition of U.S. strategic nuclear forces (SNF) to determine their utility in the fulfilling the purported objectives of a countervailing strategy [Ref. 12: p. 223].

B. U. S. STRATEGIC NUCLEAR FORCES (SNF)

The strategic nuclear forces of the United States are distributed among three legs of a strategic TRIAD, and the following excerpt from the Fiscal Year 1986 Annual Report explains the rationale for this particular disposition:

The combined effect of having three complementary legs complicates Soviet attack planning and any efforts to prevent U.S. retaliation. The existence of three legs provides, in addition, an important hedge against the possibility that a single Soviet technological breakthrough could threaten our overall deterrent capability. To deter successfully all types of nuclear attack, our forces as a whole must possess a number of characteristics and capabilities--including survivability, prompt response, endurance, mission flexibility, and sufficient accuracy and warhead yield--to retaliate against hardened Soviet military targets (emphasis added). [Ref. 10: p. 51]

Again, the emphasis on the ability to affect primarily countermilitary retaliatory strikes and the fairly explicit avoidance of a countervalue mission for U.S. strategic nuclear forces is encountered on this official statement.

The strategic TRIAD consists of land based intercontinental ballistic missiles (ICBMs), long range strategic bombers, and submarine launched ballistic missiles (SLBMs). The composition of these forces, as of 1 January 1985, is provided as Table I [Refs. 13,14,15: pp. 19,291-292,13-16].

TABLE I
U. S. STRATEGIC NUCLEAR FORCES

ICBMs

Model	Deployed	Warheads (total)	Yield(MT)	CEP(nm)
Titan II	30	30	9.00	0.70
Minuteman II	450	450	1.20	0.20
Minuteman III (Mk12)	250	750	0.17(ea)	0.12
Minuteman III (Mk12A)	300	900	0.34(ea)	0.12

SLBMs

Model	Deployed	Warheads (total)	Yield(MT)	CEP(nm)
Poseidon (C-3,C-4)	304	2736	0.04(ea)	0.25
Trident C-4	312	2496	0.10(ea)	0.25

BOMBERS

Model	Deployed	Warheads (each)	Yield(MT)	CEP(nm)
B-52G (a)	167	4(bombs) 6(SRAMs)	1.00 0.20	0.10 0.20
B-52H (b)	96	12(ALCMs)	0.20	0.08
FB-111	61	4(bombs) 2(SRAMs)	1.00 0.20	0.10 0.20

Notes:

{a) Short Range Attack Missiles.

{b) Air Launched Cruise Missiles.

Each leg of the strategic TRIAD possesses its own unique advantages and limitations. Submarines, for example, represent a relatively invulnerable retaliatory force given their operational environment and the current state-of-the-art in Soviet anti-submarine warfare (ASW) [Ref. 14: pp.109-117]. However, they are not particularly well suited for retaliatory strikes against significantly hardened targets, due to lesser accuracy in warhead delivery capability (measured by "circular error probable" or "CEP") and relatively low

weapon yields. Furthermore, the same operational environment which enhances their security also serves to exacerbate the difficulties inherent in maintaining good shore to submarine communications necessary for positive control.

Land-based strategic bombers, on the other hand, possess the necessary characteristics for affecting non-urgent hard target kills (HTKs) due to payload considerations (higher yield weapons) and the ability of the platform to achieve a great degree of accuracy in weapons delivery (low CEPs). In addition, strategic bombers offer an attractive feature through their recallability, a function not found in the other components of the Triad. Successful completion of the bomber mission, however, is predicated on the ability of the bombers to get airborne quickly in the event of a surprise attack and the ability to effect a penetration of hostile airspace.

Land-based ICBMs are generally regarded as the best system for achieving prompt hard target counterforce strikes. ICBMs fulfill the characteristics and capabilities of prompt response, accuracy and yield stipulated in the Fiscal Year 1986 Annual Report. The goal of mission flexibility is also achieved by these systems; utilization of ICBMs in a retaliatory strike presents fewer command, control and communications difficulties than the SLBM and strategic bomber legs of the TRIAD. The chief disadvantage associated with this weapons system, however, lies in its stationary deployment mode and subsequent vulnerability to attack by Soviet HTK ICBM systems. This would tend to raise questions concerning the ability of U.S. ICBMs to meet the requisite strategic force characteristics of survivability and endurance, a point addressed in detail in this and subsequent chapters.

The preceding discussion suggests that the land-based ICBM leg of the TRIAD possesses a qualitative superiority

greater than that found in the remaining elements of the U.S. strategic nuclear force structure in the execution of countermilitary targeting plans. It is also possible to substantiate this notion through quantitative analytical methods. Particularly useful is the following technique for modeling ballistic missile kill probabilities.

1. Countermilitary Potential of U.S. SNE

The probability that a single reliable warhead can be expected to destroy a given target is a function of the destructive effect of the warhead on the target and the accuracy of the warhead, assuming ideal environmental considerations and optimal height of burst (HOB) detonation. [Ref. 16: pp. 210-215]. This probability, known as the "Single Shot Kill Probability" (SSKP), may be calculated by the equation

$$\text{SSKP} = 1 - \exp\left\{(-5.83Y^2/H^3)/(H^{0.7}(CEP^2))\right\}, \quad (\text{eqn 2.1})$$

where Y equals the weapon yield in megatons (MT), H the hardness of the target in pounds per square inch (psi), and CEP, or "circular error probable," represents the maximum distance from the target where a given warhead will land with a probability of fifty percent [Ref. 16: p. 214].

Using the performance data for U.S. strategic nuclear forces provided in Table I and equation 2.1, the SSKPs for the ICBM and SLBM elements of the TRIAD against various levels of target hardness are derived and provided as Table II. Since the present emphasis is on the ability to affect prompt hard target kills, the strategic bomber force elements are omitted from these calculations.

Davis and Schilling [Ref. 16: pp. 216-217] note that the Single Shot Kill Probability is predicated on the assumption that a warhead will arrive at its designated target and detonate. This might not always be the case, as

TABLE II
APPROXIMATE U.S. ICBM/SLBM SSKP DATA

ICBMs

Model	Target Hardness (psi)					
	5	1000	2000	3000	4000	6000
Titan II	1.00	0.34	0.22	0.17	0.14	0.11
Minuteman II	1.00	0.73	0.55	0.45	0.39	0.31
Minuteman III (Mk12)	1.00	0.76	0.59	0.49	0.42	0.34
Minuteman III (Mk12A)	1.00	0.90	0.75	0.65	0.58	0.48
MX (proposed) (a)	1.00	1.00	1.00	0.99	0.97	0.93

SLBMs

Model

Poseidon (C-3,C-4)	0.99	0.10	0.06	0.05	0.04	0.03
Trident C-4	1.00	0.16	0.10	0.08	0.06	0.05

Notes:

(a) Based on Warhead Yield of 0.35MT, CEP of 0.05nm.

there are many points of possible failure during a ballistic missile's flight. Therefore, to accurately estimate the actual probability of target kill, or Terminal Kill Probability (TKP), the Overall Reliability (OAR) given missile system must be taken into consideration. OAR represents the composite probability that the missile system will not sustain a debilitating malfunction during the countdown and launch, flight, reentry vehicle busing, atmospheric penetration, and warhead detonation phases of the missile's operational profile (denoted by the subscripts l,f,b,r, and d, respectively, in equation 2.2 below).

Since these five separate phases of a ballistic missile's flight profile represent mutually exclusive probabilistic events (i.e., total failure at any given phase

precludes the delivery of a reliable warhead on target), the OAR is determined by taking the product of the reliabilities of the previously mentioned missile mission elements ("R"), or

$$OAR = (R_1)(R_f)(R_b)(R_r)(R_d). \quad (\text{eqn 2.2})$$

A missile system enjoying a 95 percent reliability in each of the above phases, for example, would have an OAR of (.95)⁵, or approximately 77 percent.

Terminal Kill Probability (TKP) is calculated by taking the product of the SSKPs and OARs for each delivery system. Table III combines the SSKP data in Table II with an arbitrarily high OAR value of 90 percent (equivalent to 98 percent reliability per phase) to provide TKP values for U.S. strategic nuclear delivery systems at near perfect levels of system performance against targets of varying hardness.

Expected value theory [Ref. 17: p.125] provides a means for evaluating the ability of U.S. SNF assets to affect kills against hardened military targets. For example, assuming a uniform availability rate of 100 percent for alerted U.S. ICBM forces and an estimated average Soviet ICBM silo hardness of 3000 psi [Ref. 18: p.22], the respective total U.S. ICBM warhead (less the MX) and 3000 psi TKP data in Tables I and III would yield a value of (30)(.15) + (450)(.41) + (750)(.44) + (900)(.59), or 1051 viable HTK ICBM warheads for the U.S. in an uncontested exchange. This methodology and the data in Tables I and III may be used to evaluate the effectiveness of U.S. SNFs against various combinations of target hardness and U.S. force availability rates.

TABLE III
APPROXIMATE U. S. ICBM/SLBM TKP DATA

ICBMs

Model	Target Hardness (psi)					
	5	1000	2000	3000	4000	6000
Titan II	0.90	0.31	0.20	0.15	0.13	0.10
Minuteman II	0.90	0.66	0.50	0.41	0.35	0.28
Minuteman III (Mk12)	0.90	0.68	0.53	0.44	0.38	0.31
Minuteman III (Mk12A)	0.90	0.81	0.68	0.59	0.52	0.43
MX (proposed)	0.90	0.90	0.90	0.89	0.87	0.84

SLBMs

Model

Poseidon (C-3,C-4)	0.89	0.09	0.05	0.05	0.04	0.03
Trident C-4	0.90	0.14	0.09	0.07	0.05	0.05

C. SOVIET DOCTRINE

A general understanding of the strategic doctrine of the Soviet Union is essential in the development of appropriate strategies designed to countervail Soviet ambitions. Doctrinal considerations provide the impetus for acquisition of force structures and employment policies best suited for the attainment of the overall Soviet goals and objectives. When equipped with this knowledge, the analyst is better prepared to establish the actual intent of the Soviet strategic planning process. This approach is superior to an alternative methodology of estimating strategic intent by simply examining raw military potential.

Due to the cloistered nature of Soviet society, efforts to ascertain the composition and objectives of Soviet nuclear strategy are equally (if not more) susceptible to

the conceptual and historical confusions encountered in a comparable study of U.S. doctrine. Nevertheless, a great many authoritative works have been written on the subject; this section presents a brief compilation of the fundamental attributes of Soviet strategic nuclear policy on which Soviet experts have reached a general consensus.

First, Soviet interpretations of deterrence theory are predominately divergent from the U.S. viewpoint. This divergence may in part be attributed to certain conceptual dilemmas. For example, Holloway notes that the term "deterrence" has no precise Russian language equivalent and is subject to two entirely different translations:

Of these two terms it is sderzhivanie, restraining or holding back, that is used to describe Soviet policy; when ustrashenie, intimidation, is used it is applied to Western policy. The fact that the same Russian word can denote both 'containment' and 'deterrence' underlines the point that deterrence is conceived of more broadly in the Soviet Union than in the West, where it is often seen solely in terms of the balance of arrangements between the two sides (emphasis added). [Ref. 19: p. 33]

Nor are translational difficulties themselves the sole contributors to conceptual confusion. While it is true that a fundamental role of Soviet strategic nuclear forces is the deterrence of an attack on the Soviet Union, analyses of Soviet military and political literature provide no evidence suggesting an acceptance of the notion of "mutual restraint" inherent in Western interpretations of deterrence theory [Ref. 14: p. 186]. The Soviets do not view deterrence as a bilateral mechanism which provides them with incentives to pursue policies stressing conflict avoidance. This contrast with the Western emphasis on war prevention, according to Ermarth, is primarily due to the "military underpinnings of a foreign policy that has both offensive and defensive goals" (emphasis added). [Ref. 9: p. 602] In short, Soviet nuclear policy seeks "not simply to deter an attack on the

USSR but to intimidate the opponent to the point of paralyzing his will to resist Soviet geopolitical advances" (emphasis added). [Ref. 14: p.186]

Second, the Soviets explicitly reject the Western deterrent paradigms of mutual vulnerability and societal punishment. While the Soviets acknowledge the potentially vast destruction associated with nuclear warfare, they are equally cognizant of the great countermilitary potential inherent in nuclear weaponry and have developed "a concept of victory that includes regime maintenance, recovery and reconstruction; and the destruction of U.S. war-waging potential as the immediate essential criteria for victory" (emphasis added). [Ref. 7: p.127] Soviet military and political literature is replete with examples suggesting the advocacy of a nuclear warfighting strategy that is predominately (but not exclusively) counterforce in its orientation. Consider the following representative quote from the third edition of Military Strategy (1968) by Soviet Marshal V.D. Sokolovskiy:

Military strategy under conditions of modern war becomes the strategy of deep nuclear rocket strikes in conjunction with the operations of all services of the armed forces to effect a simultaneous defeat and destruction of the economic potential and armed forces throughout the enemy territory, thus accomplishing the war aims within a short time period (emphasis added). [Ref. 20: p.291]

Finally, Soviet doctrine stresses the criticality of achieving strategic surprise through massive, preemptive attacks. The Soviet view of a successful first strike is one in which the United States is caught unaware, and has as its key objective the destruction of the bulk of U.S. strategic forces to preclude the possibility of a coordinated counter-strike [Ref. 21: p.6]. Miller describes the historical precedence for this strategy of massive preemption:

As assiduous students of military history, the Soviets are certainly aware of the fact that the key to victory

in coalition warfare has always been the destruction of the military capabilities of the most powerful member. Given the Soviet style of warfare and given the leadership's visceral reluctance to rely on the philanthropy of the enemy, it is most unlikely that if limited options are part of the Soviet nuclear repertoire, they resemble the warning shots, demonstration strikes, and highly selective targeting associated with American limited nuclear options (LNO). Rather, the Soviet version of limited options almost assuredly would conform to the dual imperatives of achieving a quick and decisive result and reducing the enemy's ability to inflict damage on the homeland (emphasis added). [Ref. 14: pp. 226-227]

Therefore, the Western model of deterrence which most closely approximates the intent of Soviet strategic nuclear doctrine is that of the prevailing strategy. Accordingly, the Soviets have conducted an ongoing expansion and modernization of their strategic nuclear force structure to fulfill the primary objective of this strategic paradigm: the imposition of military defeat on the West while simultaneously securing the achievement of Soviet political goals and objectives.

D. SOVIET STRATEGIC NUCLEAR FORCES

In order to complicate attack planning and to widen the spectrum of available warfighting options, the strategic nuclear forces of the Soviet Union are arranged in a structure roughly analogous to the U.S. TRIAD. The composition of these forces, as of 1 January 1985, is provided as Table IV [Refs. 13,14,15: p. 19,291-292,13-16].

1. Countermilitary Potential of Soviet SNF

The methodology employed in the previous section for evaluating the countermilitary potential of U.S. SNFs enjoys equal validity in the Soviet case. Tables V and VI, respectively, provide single shot kill and terminal kill probability values (assuming an arbitrary 90 percent overall reliability) for Soviet ballistic missile systems.

TABLE IV
SOVIET STRATEGIC NUCLEAR FORCES

ICBMs

Model	Deployed	Warheads (total)	Yield(MT)	CEP(nm)
SS-11	520	520	1.00	0.76
SS-13	60	60	0.60	0.82
SS-17	150	600	0.75(ea)	0.24
SS-18	308	3080	0.50(ea)	0.12
SS-19	360	2160	0.55(ea)	0.14

SLBMs

Model	Deployed	Warheads (total)	Yield(MT)	CEP(nm)
SS-N-5	45	45	1.00	1.50
SS-N-6	336	672	0.75(ea)	1.00
SS-N-8	292	292	0.80	0.84
SS-N-17	12	12	0.75	0.25
SS-N-18	224	672	0.20(ea)	0.76
SS-N-20 (a)	60	840	0.20(ea)	0.25

BOMBERS

Model	Deployed	Warheads (each)	Yield(MT)	CEP(nm)
BEAR	120	4	1.00	0.20
BISON	45	4	1.00	0.20
BACKFIRE (b)	230	2	1.00	0.10

Notes:

(a) SLBMs carried on TYPHOON class SSBNs.

(b) Includes Soviet strategic and naval aviation assets.

Using the previously described technique of expected values along with assumptions of 100 percent availability for Soviet Strategic Rocket Force (SRF) ICBMs and an average U.S. ICBM silo hardness of 2000 psi [Refs. 18,22: pp. 22,412] the respective total warhead and 2000 psi TKP data in Tables IV and VI would yield a value of $(520)(.05) + (60)(.03) + (600)(.34) + (3080)(.75) + (2160)(.56)$, or 3752 viable HTK ICBM warheads for the Soviets in an uncontested exchange.

TABLE V
APPROXIMATE SOVIET ICBM/SLBM SSKP DATA

<u>ICBMs</u>		Target Hardness (psi)			
Model		5	1000	2000	3000
SS-11		0.96	0.08	0.05	0.04
SS-13		0.86	0.05	0.03	0.03
SS-17		1.00	0.54	0.33	0.30
SS-18		1.00	0.95	0.83	0.74
SS-19		1.00	0.79	0.62	0.51
<u>SLBMs</u>					
Model					
SS-N-5		0.57	0.02	0.01	0.01
SS-N-6		0.79	0.04	0.02	0.02
SS-N-8		0.90	0.05	0.03	0.03
SS-N-17		1.00	0.47	0.33	0.26
SS-N-18		0.67	0.03	0.02	0.01
SS-N-20		1.00	0.23	0.15	0.11

E. SUMMARY

Three important conclusions may be derived from this chapter. First, an analysis of official policy statements by U.S. leadership substantiates the hypothesis that the United States does not adhere to the doctrine of mutual vulnerability in the formulation of its nuclear strategy. While the concept of mutual vulnerability might possess a certain intellectual appeal, U.S. declaratory nuclear policies are in reality decidedly counterforce in their orientation. This doctrinal predisposition towards a strategy emphasizing "countervailing options" has produced a nuclear force structure that is primarily designed for the flexible execution of countermilitary as opposed to countervalue missions.

Second, the Soviet Union has unequivocally rejected the notions of mutual restraint and assured vulnerability

TABLE VI
APPROXIMATE SOVIET ICBM/SLBM TKP DATA

ICBMs

Model	Target Hardness (psi)			
	5	1000	2000	3000
SS-11	0.86	0.07	0.05	0.04
SS-13	0.77	0.05	0.03	0.02
SS-17	0.90	0.49	0.34	0.27
SS-18	0.90	0.86	0.75	0.67
SS-19	0.90	0.71	0.56	0.46

SLBMs

Model	5	1000	2000	3000
SS-N-5	0.51	0.02	0.01	0.01
SS-N-6	0.71	0.04	0.02	0.02
SS-N-8	0.81	0.05	0.03	0.03
SS-N-17	0.90	0.42	0.30	0.23
SS-N-18	0.60	0.03	0.02	0.01
SS-N-20	0.90	0.21	0.14	0.10

inherent in Western deterrence theory. The Soviets see deterrence as a mechanism which diminishes the probability of a U.S. attack while facilitating a paralysis of the Western will to resist Soviet expansionist tendencies. Furthermore, Soviet strategy has enjoyed a remarkable continuity unparalleled in the West, with consistent emphasis on the classic Clausewitzian principles of mass and economy of force, as well as the attainment of strategic surprise through preemption [Ref. 9: p. 605].

Third, a cursory examination of the countermilitary potential of both the United States and Soviet strategic nuclear forces indicates a decided Soviet advantage in reliable HTK capable ICBMs (3752:1051, or 3.6:1). Although the assumptions used in the expected value methodology included several artificialities (high OARs and near perfect system

availability), the implications of this imbalance on the viability of U.S. SNF, particularly that of the ICBM force, are severe. This point will be examined further in the following chapters.

III. STRATEGIC DEFENSE FOR COUNTERFORCE ENHANCEMENT

A. OBJECTIVES FOR STRATEGIC DEFENSE

An initial requirement of the measures of effectiveness methodology is the identification of alternative approaches for reaching a specified objective. Accordingly, this chapter begins with a review of several possible objectives for a system of strategic defense. Bowman [Ref. 23: p. 871] identifies four:

- (1) to replace a policy of deterrence by threat of retaliation with a policy of assured survival based on a near-perfect defense against all types of offensive nuclear weapons;
- (2) to enhance deterrence by reducing the vulnerability of U.S. retaliatory offensive forces;
- (3) to create a first strike capability by effectively shielding against the small residual Soviet force left following U.S. preemption; and
- (4) to limit damage by reducing the number of penetrating Soviet warheads, should deterrence fail.

Each of these objectives represents a differing strategic approach for conflict management, ranging from total defense dominance to varying mixes of offensive and defensive capabilities. Additionally, each objective carries with it a unique set of technological and political challenges. The issue at hand is the identification of the objective best suited to the declaratory goals of U.S. nuclear strategy.

Objective (1) may be clearly interpreted as a defense dominant approach. Pursuit of policies, systems and technologies conforming to this objective would acknowledge mutually assured vulnerability as the preeminent deterrent paradigm in the U.S.-Soviet relationship. By definition, systems of strategic defense designed to fulfill this objective would have to be "near-perfect" in order to preclude any possibility of incurring massive societal punishment from any type of nuclear delivery system. The immensity of

the technological challenge associated with such a task is readily apparent.

The political implications of this strategy are equally formidable. First, this approach would necessitate the unilateral elimination of offensive strategic nuclear capabilities from the U.S. arsenals. Bowman explains the rationale for this requirement:

Otherwise, a nation protected behind such a shield could threaten its neighbors in the world community with impunity, even with a small number of nuclear weapons. If a nation attempted to complete such a system while retaining offensive weapons, the other nations would never allow it, but would attempt to destroy the shield before it was complete or launch a preemptive attack. [Ref. 23: p.872]

While the historical record would tend to support the notion that an inexplicably sudden adoption of a malevolent posture by the United States toward the international community is very unlikely, the implications of this scenario on Soviet grand strategy are obvious. The Soviets might perceive such a development as reflective of U.S. desires to actually acquire a potentially viable nuclear war-fighting/war-winning posture. In addition, the transition from the current offense dominant strategy to the defense dominant strategy embodied in objective (1) would have to be very carefully orchestrated indeed so that at no time would the offensive/defensive mix create the situation found in objective (3): the capability for a disarming first strike [Refs. 23,24: pp.871, 824-825].

Finally, objective (1) would be tantamount to a rejection of deterrence as the cornerstone of U.S. strategic doctrine. The declaratory policies of the United States stress the prevention of warfare at all levels of the spectrum of conflict through the mechanism of deterrence. According to Defense Secretary Weinberger's FY87 Annual Report [Ref. 11: p.39], deterrence is a multilayered concept comprised of the following components:

- Defense: if the adversary calculates his aggression is likely to fail in its own terms, he will not attack;
- Escalation: the adversary must know that even if his aggression should succeed in achieving its immediate objectives, he faces the threat of escalation to hostilities that would exact a higher cost than he is willing to pay; and
- Retaliation: if the adversary confronts a credible threat that aggression will trigger attacks by a surviving U.S. retaliatory capability against the attacker's vital interests that result in losses exceeding any possible gains, he will not attack.

The strategic nuclear forces of the United States play an integral role in the actualization of these processes. The requisite removal of these forces as specified in objective (1) to assuage international suspicions of a developing U.S. nuclear war-winning capability would effectively terminate the viability of the second and third aspects of deterrence. Furthermore, this totally passive, defense dominant posture would require absolute confidence in the effectiveness of the defenses deployed, thereby placing an unprecedented burden on the first mechanism. Taken together, these two factors would likely render the entire deterrent process impotent.

Conversely, objectives (3) and (4) are representative of approaches which seek to establish a mix of offensive and defensive strategic capabilities. It is arguably correct that sound military judgement dictates the pursuit of force structures containing a well balanced offensive/defensive mix. It is equally true that the technological demands on defensive systems outlined for these objectives are significantly less and more readily obtainable than those required for objective (1). The issue with objectives (3) and (4), however, is not one of technological feasibility but rather one of domestic and international political implications.

First, the development of policies, systems and technologies conforming to objectives (3) and (4) might be legitimately construed as the advocacy of a posture designed to fulfill the objectives of nuclear war-fighting or perhaps

even war-winning strategies. Pursuit of these objectives would be appropriate if the paradigm of the prevailing strategy, with its emphasis on victory as opposed to denial, is truly representative of U.S. strategic goals. Since this is not the case, adoption of this posture would be diametrically opposed to the stated intent of U.S. strategic nuclear policies and would have serious ramifications at the domestic political level. Even the most cursory review of official U.S. policy statements yields a collection of documents replete with phrases reflecting the national sentiment on the topic of nuclear conflict and reiterating the theme that "a nuclear war cannot be won and must never be fought." [Ref. 11: p.14]

Furthermore, historical observations of the post-war period lend additional credence to the rejection of the preemptive strategy as a viable option in U.S. nuclear doctrine. Although the "nuclear option" was reportedly considered twenty times in successive presidential administrations since 1945, the United States obviously did not choose to exercise this option [Ref. 25: p.626]. If anything, the likelihood of a Presidential order initiating the nuclear option has declined over the past decade [Ref. 8: p.588].

The development of the defensive strategies and systems delineated in these two approaches would also have grave perceptual implications for the continued security of the Western Alliance. Gray and Payne note that despite its shortcomings, the current offensive dominant nuclear posture of the United States remains central to the NATO doctrine of "flexible response" and the concept of "enhanced deterrence." [Ref. 24: p.829] Even though the defensive transitions envisaged in objectives (3) and (4) would still provide the U.S. with an offensive/defensive force mix with potent retaliatory capabilities, it is unlikely that

America's European allies would welcome such a development. Two basic arguments support this hypothesis.

In the first place, it is extremely unlikely that the Soviet Union would permit a unilateral deployment of strategic defenses by the United States designed to facilitate the execution of either preemptive or damage-limiting strategies. Since the Soviets have long recognized the utility of strategic defenses in the conduct of offensive operations, it is most likely that the Soviet Union would seek to match (if not actually exceed) U.S. defensive capabilities when confronted with (or anticipating) this situation [Ref. 26: pp. 20-22]. The resulting bilateral deployment of comparable systems of strategic defense by both superpowers would still leave the Soviet Union with a clear advantage in counter-force capabilities. In the face of effective Soviet defenses, the U.S. "nuclear umbrella" associated with the doctrines of "flexible response" and "extended deterrence" would appear less threatening and might well compel America's European allies to seek "alternative means of preserving their security." [Ref. 24: p. 830] Achievement of these "alternative means" could only come about as the result of an unprecedented expansion of NATO's conventional and nuclear offensive and defensive capabilities. An examination of the historical record has shown this choice to be decidedly unpalatable from a European viewpoint [Ref. 27: pp. 628-629].

Secondly, the nations of the Western Alliance are faced with a wider spectrum of potential threats than the United States:

A BMD (Ballistic Missile Defense) system that effectively protected the United States and its European allies from strategic nuclear attack would still leave the Europeans vulnerable to conventional and some kinds of nuclear attack. This asymmetry in vulnerabilities, and hence the perception of an asymmetry in American and European interests, could be exacerbated by a new U.S. defensive policy (emphasis added). [Ref. 24: p. 830]

Moreover, a bilateral defensive transition by both superpowers towards the offensive/defensive mixes stipulated in objectives (3) and (4) would effectively diminish the utility of the strategic nuclear forces of the "small" nuclear powers:

A defensive transition by both superpowers would also degrade, perhaps nullify, the British and French independent strategic deterrents. It was clear during the SALT I negotiations that the British and French wanted BMD limited to very low levels so that their relatively small independent nuclear forces would retain effectiveness. There is little to indicate that the British or French have a different perspective today (emphasis added). [Ref. 24: p.830]

In brief, the varying degrees of technological and political difficulties associated with the defensive transitions specified in objectives (1), (3) and (4) are extensive and have many potentially undesirable consequences. These dilemmas hold equally well in scenarios that seek a less than total defensive transition as in those that seek absolute defence dominance. This is not the case, however, with Bowman's second objective: using strategic defenses to enhance deterrence.

B. STRATEGIC DEFENSE TO ENHANCE DETERRENCE

The use of strategic defense to enhance the deterrence process enjoys viability as a strategic option for the very same reasons that the alternative approaches do not. Deterrence has ostensibly been implemented through the adoption of a variety of strategic paradigms throughout the evolution of U.S. strategic doctrine. As was demonstrated in Chapter II, the stipulations of the countervailing strategy best reflect the true intent of U.S. nuclear policies and programs at present. Nevertheless, the concept of deterrence itself has in one form or another remained the cornerstone of United States strategic doctrine for over forty years. Thus, the issue becomes one of how to best fortify an

established and proven concept as well as provide a "hedge" against the possible failure of the deterrence process.

There is little if any serious contention that deterrence has not achieved its single overriding objective: the prevention of a direct superpower clash across the entirety of the spectrum of conflict. It is reasonable to assume that the immediate and quite possibly long term future will not witness an intentional departure by the United States from this position. Therefore, any serious effort by the United States to develop a truly meaningful system of strategic defense must first meet the criteria of deterrence enhancement.

The emphasis in the preceding paragraphs, however, is on the avoidance of defensive strategies which might facilitate an intentional U.S. departure from the deterrence process. Several trends are apparent in the current U.S.-Soviet strategic nuclear "balance" which might serve as potential catalysts of an unintentional divestiture of the deterrence process by the United States. The burgeoning Soviet capability for conducting effective preemptive counterforce strikes could conceivably force the U.S. to adopt a preemptive strategy of its own in crisis situations. In particular, substantial evidence has accrued suggesting that certain elements of the strategic TRIAD, most notably the land-based ICBM force, have become increasingly vulnerable to a preemptive Soviet counterforce strike. The eventual development of this situation was officially recognized several years ago by Secretary of Defense Harold Brown in the Fiscal Year 1981 Annual Report:

Within a year or two, we can expect (the Soviets) to obtain the necessary combination of ICBM numbers, reliability, accuracy and warhead yield to put most of our Minuteman and Titan silos at risk from an attack with a relatively small portion of their ICBM force. . . We must assume that the ICBM leg of our Triad could be destroyed within a very short time as one result of a Soviet surprise attack. [Ref. 28: p. 21]

A cursory examination of the hard target kill (HTK) capabilities of the current Soviet ICBM order-of-battle (Tables IV, V and VI) clearly indicates that the vulnerability predicted less than a decade ago has been transformed into a strategic reality. It is also apparent that the burgeoning Soviet capability to effect prompt destruction of hardened U.S. ICBM silos poses an equally potent threat to the survivability of a substantial portion of the remaining legs of the TRIAD (i.e., strategic bombers and import SSBNs).

The implications of this growing disparity in the U.S.-Soviet strategic balance on the continued vitality of the deterrence process are severe. According to the Fiscal Year 1987 Annual Report [Ref. 11: pp. 33-34], an effective deterrent must meet four tests:

- Survivability: forces must be able to survive a preemptive attack with sufficient strength to threaten losses that outweigh gains;
- Credibility: threatened responses to an attack must be of a form that the potential aggressor believes could and would be carried out;
- Clarity: actions to be deterred must be sufficiently clear so the potential aggressor knows and recognizes what is prohibited; and
- Safety: failures due to accidents, unauthorized use, and miscalculations must be minimized.

However, the increasing leverage manifested in the current Soviet ICBM order-of battle seriously jeopardizes the ability of the U.S. land-based ICBM force to successfully meet the preceding criteria. This leverage may be qualitatively and quantitatively demonstrated with the use of a simple dynamic counterforce exchange model.

C. SOVIET COUNTERFORCE SCENARIO

A common shortcoming associated with many dynamic nuclear exchange models is their failure to conduct a realistic assessment of the targeting objectives of the aggressor force. Accordingly, this section commences with a review of the representative literature dealing with the

war-fighting objectives of the Soviet Union as a precursor to the development of a plausible Soviet counterforce first strike scenario.

1. Soviet Targeting Considerations

The analysis of Soviet strategic doctrine in Chapter II established the prevailing strategy as the comparable Western paradigm which best approximated the overall objectives of Soviet grand strategy. Since the prevailing strategy stresses the imposition of military defeat while simultaneously seeking the achievement of the aggressor's goals as its primary objective, it is not surprising that Soviet nuclear targeting has objectives which conform with that approach. Deane identifies two:

Soviet targeting has two general objectives that are consistent with the intent of attaining victory over the opponent. The first is the greatest possible destruction of enemy military forces, especially the enemy's strategic nuclear capabilities; second is the destruction of selected key political and economic targets as a means both to inhibit the enemy's ability to sustain a protracted war effort and to overcome the population's will to resist (emphasis added). [Ref. 26: pp. 17-18]

A plausible target set representative of Soviet objectives in a nuclear conflict would thus adopt the general schema developed by Frank [Ref. 29: pp. 12-13]:

- Destruction of enemy nuclear attack capabilities;
- Destruction or disruption of enemy troop basing systems;
- Destruction of enemy military-industrial support facilities;
- Destruction or disruption of enemy rear services and transport facilities.

Identification of the offensive tactics most likely to be employed in the fulfillment of Soviet targeting objectives is a more demanding task. Sound military logic would dictate that a prudent Soviet planner not anticipate an overwhelming attrition of U.S. strategic nuclear assets with

an initial Soviet salvo. Taking this logic one step further, Soviet planners must also not discount the possibility of a totally countervalue oriented "spasm" U.S. retaliatory attack. Despite the relatively low probabilities associated with these two events, the Soviets would nevertheless do well to take them into consideration.

Therefore, Soviet planners may be expected to draw primarily from two tactical options in their repertoire. Miller explains the rationale for the first choice:

The only plausible way to achieve a substantial increase in attrition would be for the Soviets to strike before U.S. forces were placed on high alert; that is, in a period of less than extreme tension. This suggests two possible scenarios. The first, and most obvious, is the bolt-out-of-the-blue attack. In the absence of capabilities that have an extraordinary damage limitation potential, such an action must rank at the extreme low end of the probability scale. Indeed, a strong and confident Soviet Union is less likely to consider nuclear war than is a weakened and desperate one (emphasis added) [Ref. 14: p.216].

Miller concludes the analysis by positing the more likely Soviet nuclear option:

The more likely scenario, then, is some calamity faced by the Soviets, the full military implications of which were unappreciated in the West. If, for instance, the leadership was confronted with severe internal dislocations at home or within the bloc, coupled with declining confidence in its ability to uphold its end of the superpower competition, it would certainly be willing to take grave measures to salvage its crumbling position. The formidable counterforce capabilities the Soviets will have by the mid-1980s could be especially destabilizing and dangerous in this kind of situation. Indeed, the Kremlin might feel sorely pressed to act decisively, in order to neutralize American power before Washington moved to achieve some fundamental advantage. The possibility that the Soviet leadership is susceptible to such a now-or-never mentality should not be dismissed precipitously (emphasis added). [Ref. 14: pp.216-217]

A final consideration in the development of Soviet targeting objectives is addressed with a brief examination of the following concepts: strategic reserves and economy of force. As assiduous students of classical military

strategy, the Soviets have long recognized the necessity for holding sizeable, secure strategic forces in reserve during the course of battle [Ref. 14: p.149]. This penchant for the maintenance of large reserve forces is wholly consistent with Soviet expectations of a protracted nuclear conflict with the United States [Refs. 5,4: pp.42,612]. In addition, emphasis on the military principle of economy of force exerts a significant influence on Soviet target planning; random applications of violent force are generally regarded as anathema to the Soviet strategic culture [Ref. 9: p.605].

Taken together, these targeting considerations would produce the initial Soviet nuclear salvo envisaged by Miller: approximately 2500 prompt counterforce warheads with an equivalent megatonnage of roughly 1500MT of explosive power [Ref. 14: p.227]. The hypothetical Soviet first-strike examined in the subsequent section approximates this scenario scenario quite closely.

2. A Hypothetical Soviet Counterforce Model

The following model illustrates the likely composition of a Soviet counterforce strike consistent with the targeting objectives developed in the preceeding sections. Accordingly, the scenario places great emphasis on attaining an attack disposition necessary to achieve the overriding goal of a Soviet first strike: the effective neutralization of retaliatory U.S. nuclear capabilities embodied in the land-based ICBM, strategic bomber, and non-deployed SSBN elements of the TRIAD. Several qualifications, however, are in order.

To begin with, the scenario assumes that U.S. strategic nuclear contingency planning documents (i.e., the Single Integrated Operational Plan, or SIOP) explicitly disavow either launch-on-warning (LOW) or launch-under-attack (LUA) policies as legitimate nuclear options. This assumption is not altogether without foundation as the

current warning and surveillance network deployed by the U.S. is not sufficiently adequate in sensitivity to provide a comfortable basis for the adoption of these policies [Ref. 7: p.172]. Furthermore, LOW or LUA policies would mandate the delegation of nuclear release authority, a function exclusively associated with the highest levels of U.S. political leadership, considerably further down the National Command Authority (NCA) chain of command [Ref. 7: p.175]. The model therefore assumes that the U.S. strategic nuclear forces would be opted into "riding-out" an initial Soviet assault.

Second, although the model stresses destruction of significantly hardened U.S. retaliatory assets (ICBMs), the less hardened elements of the TRIAD (inport SSBNs, Bombers) are also included in the scenario. The rationale for this decision is derived from a synthesis of Soviet targeting objectives with expected Soviet ICBM performance. Since Soviet strategic doctrine emphasizes both the expeditious destruction of all U.S. SNF and the military significance of qualitatively superior weaponry [Ref. 14: pp.195-200], it is logical to conclude that the Soviets would commit their most modern and capable ballistic missile systems (i.e., the SS-18 MOD4) in the execution of the attack plan. Even though the use of HTK ICBMs to destroy "soft" targets might appear "wasteful" from a Western perspective, it is nevertheless consistent with Soviet strategic thought. This tactic would guarantee the Soviets sufficient military leverage necessary to seize the highly sought-after "initiative," and must therefore not be dismissed as a viable option [Ref. 9: p.608].

Third, the scenario does not include Soviet attack options associated with the destruction or disruption of other military targets (OMT) delineated in the previous section. Examples of candidate OMT sets likely to be found

in Soviet targeting plans include U.S. SNF command, control and communications (C3) nodes, early warning and detection facilities, national command links, SSBN communications facilities and major military headquarters, to list a few [Ref. 29: pp. 12-13]. Two considerations support the intentional omission of OMT target sets from the scenario. The first, and perhaps most obvious, is the sheer size of the data base which a thorough compilation of potential OMT sets would assume. The second consideration is a function of the resiliency of the OMTs. Since the bulk of the OMT target set has little or no nuclear resistance (i.e., the ability to withstand greater than 10 psi of blast overpressure), it is most likely that their prompt destruction would be relegated to the Soviet SSBN force. An examination of the Soviet SSBN order-of-battle and systems performance data (Tables IV, V, and VI) indicates that these forces are more than capable for the execution of OMT attack plans.

After integrating the preceding qualifications into the dynamic modeling process, a hypothetical Soviet counter-force strike assumes the disposition depicted in Table VII. The scenario allocates two SS-18 warheads per target salvoed at a rate designed to ensure adequate temporal separation between warheads arriving at their respective designated ground zeroes (DGZs). This separation serves to minimize the possible fratricidal effects associated with two-on-one targeting scenarios. Substantial evidence exists suggesting that the Soviets are well aware of this phenomenon and have developed the requisite command and control capabilities to surmount this potential obstacle to attack success [Ref. 30: pp. 20-21].

Table VI (see Chapter II) illustrated the potential hard and soft target kill capabilities of the Soviet ICBM and SLBM systems as a function of their respective terminal kill probabilities (TKPs). These values, however, are

TABLE VII
SOVIET FIRST STRIKE SCENARIO

207 SS-18 MOD4s, 10 WARHEADS EACH (a)

Target	Hardness	Total Targets	Warheads Used
ICBM LCCs (b)	2000 psi	133	266
Titan II	"	33	66
Minuteman II	"	450	900
Minuteman III (Mk-12)	"	250	500
Minuteman III (Mk-12A)	"	300	600
SSBN BASES	5 psi	3	6
SAC BASES (c)	5 psi	16	32
Totals	N/A	1035	2070

Notes:

{a) Yield = 0.35MT; CEP = 0.12nm.

{b) Launch Control Centers.

{c) Strategic Air Command bases with alert aircraft.

artificially inflated by the inclusion of an arbitrarily high overall reliability (OAR) of 90 percent in the TKP calculus. In the interest of achieving greater operational fidelity in evaluating the effectiveness of this scenario, a more realistic OAR value of .77 is incorporated into the determination of SS-18 TKPs. This is analogous to individual ICBM mission phase reliabilities of 95 percent. The revised data is provided as Table VIII.

The scenario's provision of adequate temporal separation between arriving warheads permits the viewing of each warhead's attack performance as probabilistically independent events. With this qualification, the probability that a given target escapes destruction by either the first or second warhead (but not both) is determined by the equation

TABLE VIII
REVISED SOVIET SS-18 TKP DATA

	Target Hardness (psi)			
	<u>5</u>	<u>1000</u>	<u>2000</u>	<u>3000</u>
TKP	0.77	0.73	0.64	0.57

$$P_{\text{surv}} = 1 - \{P(WH1) + P(WH2) - P(WH1 \cap WH2)\}, \quad (\text{eqn 3.1})$$

where the random variables WH1 and WH2 represent the respective target kill probabilities of the first and second warheads [Ref. 31: p.24]. Substitution of the appropriate SS-18 TKP values into equation 3.1 yields overall survival probabilities of .05 for targets hardened to 5 psi and .13 for targets hardened to 2000 psi, assuming $P(WH1)$ equals $P(WH2)$.

The statistical technique for determining the expected value of a discrete random variable may now be used to determine the lethality of the hypothetical Soviet counterforce strike [Ref. 17: p.125]. Application of the overall target survival probabilities to the numerology of the attack scenario (Table VII) in accordance with the expected value methodology facilitates the determination of the post-attack composition of the targeted U.S. SNFs as an MOE of the Soviet strike. The result of this process is provided as Table IX:

TABLE IX
POST ATTACK COMPOSITION OF U.S. SNF (UNDEFENDED)

Target	Pre-attack	Post-attack (a)
ICBM LCCs	133	17
Titan II	33	4
Minuteman II	450	59
Minuteman III (Mk-12)	250	98
Minuteman III (Mk-12A)	300	117
SSBN BASES	3	0
SAC BASES	16	1

Notes:

(a) Values rounded down to nearest whole number.

A discussion of the implications of this force structure follows.

D. SCENARIO IMPLICATIONS AND SUMMARY

The situation represented by the post-attack disposition of U.S. strategic nuclear forces in Table IX is disquieting. Consider the following schema for interpreting the outcome of the hypothetical Soviet counterforce strike.

Destruction of ICBM capabilities. The Titan and Minuteman ICBM systems incurred respective losses on the order of 88 and 87 percent for an aggregate reduction of the pre-attack force level of 87 percent. The total number of warheads now available for prompt retaliatory counterforce missions rests at 278, assuming the Soviets achieved a uniform rate of silo destruction. When these "survivors" are attenuated with the applicable 3000 psi TKP values to determine their effectiveness against Soviet silos (Table III), the expected number of prompt hard target kill capable warheads diminishes to 137.

Loss of import SSBNs. Although the U.S. SSBN force provides a limited hard target kill capability, its utility in the execution of prompt non-HTK counterforce tasking is substantial. Assuming an import rate of 40 percent for both Poseidon and Trident systems [Ref. 7: pp. 176, 181], the destruction of all three SSBN bases represents the loss of approximately 2093 warheads well suited for OMT counterforce missions.

Attrition of strategic bombers. The reduction in U.S. strategic bomber strength is nearly complete. In a day-to-day alert situation, approximately 30 percent of the SAC bomber force is maintained on a "quick reaction" alert at 16 airfields [Ref. 32: p. 46]. This equates to a total alert bomber force of approximately 96 aircraft. A flight of 6 bombers would be found at each base assuming a uniform distribution of available aircraft among alert airfields. Table IX indicates that the assets of a single SAC base (6 bombers) would be expected to survive the initial Soviet strike.

Loss of LCCs. Each Titan missile system has its own separate launch control center; in the case of Minuteman an LCC provides operational control for a flight of ten missiles [Ref. 33: p. 42]. An aggregate attrition rate on the order of 87 percent for the Titan and Minuteman LCCs poses a very serious threat to the potency of the residual U.S. ICBM force. The 17 remaining launch control centers would be capable of providing operational control for no more than a total of 130 missiles (278 warheads), assuming a proportional distribution of the LCCs among the surviving Titans and Minutemen. However, a less than uniform distribution of the LCCs among the "survivors" could conceivably reduce the optimistic total of 278 available counterforce warheads to even lower levels.

As if these observations by themselves are insufficient cause for alarm, consider the additional damage inflicted on U.S. strategic nuclear capabilities by Soviet counterforce strikes against OMTs omitted from the hypothetical scenario. The likely destruction and disruption of critical C3 nodes, national command links, etc., further exacerbate an already dismal situation.

Three categories of possible responses exist for this dilemma; two are readily apparent. The first, and perhaps most obvious would dictate complete capitulation on the part of the United States in the face of an omnipotent Soviet adversary. Conversely, the second choice would mandate a U.S. retaliation using the residual ICBM, SLBM and bomber forces against the Soviet Union in a totally unrestrained "spasm" response replete with acts of random nuclear violence on a massive scale. In light of the evidence presented in this work regarding the intent of the strategic doctrine of the United States, it is suggested that the Hobson's choice represented by these two options is nothing short of ridiculous.

If, however, these two "options" accurately define the endpoints of a continuum of strategic options, then it is logical to presume the existence of a point of balance. This fulcrum must represent an optimal solution for avoidance of the dilemma presented in the preceding sections. The author's research indicates that such a balance would be best achieved through the development of a sensible strategy which incorporates strategic defense in a manner consistent with the objective of enhancing the deterrence process. As a prelude to the examination of possible measures of effectiveness for such a strategy, the subsequent chapter briefly examines the fundamental concepts, systems and technologies associated with the concept of strategic defense.

IV. CONCEPTS IN STRATEGIC DEFENSE

A. OVERVIEW

This chapter conducts a brief, non-technical review of fundamental concepts, systems, and technologies associated with strategic defenses. First, the characteristics of modern ballistic missiles are outlined to facilitate a better understanding of the technological challenges associated with strategic defense. Next, the basic goals and objectives of strategic defense and the assortment of tactical options available for the execution of this task are examined. Last, a review of proposed systems and technologies is conducted as a prelude to the formulation of MOEs for counterforce enhancing systems of strategic defense.

B. BALLISTIC MISSILE CHARACTERISTICS

An understanding of the operational characteristics of ballistic missiles is crucial in evaluating the architectures of proposed defensive systems. Two aspects of ballistic missile flight profiles warrant particular attention: the type of trajectory flown and the composite phases associated with typical ballistic missile trajectories.

Ballistic missile trajectories fall into three general categories: lofted, minimum energy and depressed. Table VII illustrates the variation in several key operational parameters for an MX type ICBM flown over several 10,000 km launch to impact profiles [Ref. 34: p. 9].

TABLE X
ICBM TRAJECTORIES

Type	reentry angle (degrees)	apogee (km)	flight time (min)
lofted	35	2300	42
minimum energy	23	1200	31
depressed	15	900	28

Each of these ballistic missile trajectories can be divided into four distinct phases:

- **Boost-phase.** Commencing at launch, this phase terminates with the burnout of the second or third stage booster motors, depending on the individual missile's design. Solid fuel ICBMs such as the U.S. MX, have boost phases averaging 180 seconds in duration and reach an altitude of 200 km when launched in minimum energy (normal) ballistic trajectories [Ref. 34: pp. 7-10].
- **Post-boost phase.** Typically several hundred seconds in duration, a postboost vehicle (PBV) maneuvers with low energy thrusters and deploys individual reentry vehicles (RVs) on precise ballistic trajectories in this phase [Ref. 35: p. 52]. In addition, the PBV releases a variety of penetration aids (penaids), such as "chaff" or aerosol clouds, to complicate tracking of the RVs by defensive systems.
- **Midcourse phase.** Beginning with the completion of RV and penaids deployment, this phase may last as long as 1000 seconds [Ref. 35: pp. 52-53]. During this time, the RVs and penaids travel on ballistic trajectories, reaching an apogee of approximately 1200km in a minimum energy trajectory [Ref. 34: p. 7].
- **Terminal (reentry) phase.** This phase begins with RV and penaids interaction with the sensible atmosphere (100 km); reentry phase duration is a function of the specific trajectory and may range from 30 to 100 seconds in length [Ref. 35: p. 53].

The boost and terminal phases of submarine launched ballistic missiles (SLBMs) and intermediate range ballistic missiles (IRBMs) are generally similar to those of ICBMs; post-boost and midcourse phases of these systems, however, are usually less extensive [Ref. 36: p. 15].

C. DEFENSIVE CONCEPTS

In the most basic terms, strategic defense systems have either point or area defense as its primary goal. Point defenses emphasize the protection of relatively small, well defined areas, such as an ICBM silo or airfield. Area systems, as the name suggests, are much broader in their defensive scope and might have the protection of large-scale industrial/urban (I/U) areas as a primary mission.

Carter [Ref. 37: pp.103-105] describes three tactical approaches associated with strategic defense. The first tactic, preferential defense, is designed to protect pre-designated portions of a potential target set. To accomplish this goal, a preferential defense concentrates its defensive effort on a specific subset of the potential target set and either keeps secret which targets it intends to defend or redirects the defensive effort at the commencement of the attack. Since the offense has no way of knowing on which target set to concentrate its assault, it is forced to attack all targets as if they were equally defended. The result is a commitment of offensive assets on undefended targets disproportionately higher than the number of deployed defensive systems.

The second approach, that of the layered defense, is designed to increase the number of opportunities available to the defense for offensive warhead destruction. Multi-layered defense is generally considered to have two distinct advantages over single-layer systems. In terms of engineering and probabilistic considerations, multi-layered systems alleviate the need to seek extremely high levels of effectiveness for each individual layer of the system. Furthermore, multi-layered systems, with their use of different sensors and weapons, diminish the capability of the offense to entirely countermeasure the system while enhancing the defense's ability to overcome offensive countermeasures [Ref. 38: p.2961].

The third concept, threshold defense, is somewhat more subtle in context. Carter explains the primary objective of this tactic:

In threshold defense it is conceded that the target can be destroyed at a price that is not prohibitive, but the presence of defense is thought to require the offense to mount a relatively large and complex attack. The scale of the attack is imagined to exceed some threshold the attacker is unwilling to cross, either because it would provoke a massive retaliation or because it would provide the victim an assured tactical warning that would mitigate the effect of the attack. [Ref. 37: p. 105]

In other words, threshold defense may be construed as a tactic designed to achieve relatively modest levels of defense while simultaneously serving as a sort of escalatory "trip-wire" over which the offense had best not tread.

D. SYSTEMS AND TECHNOLOGIES

The tactical concepts of preferential, layered, and threshold defense combine with the operational characteristics of ballistic missiles to produce a synergistic influence on the determination of defensive systems architectures. Carter [Ref. 37: pp. 120-122] groups BMD systems and technologies into five functional categories:

- traditional systems,
- simple/novel systems,
- layered defense with advanced exoatmospheric overlay and traditional underlay,
- boost-phase and directed energy systems, and
- dust defense.

Each of these is examined in the following paragraphs.

1. Traditional Defense

Traditional systems usually consist of ground-based nuclear or nonnuclear high-acceleration interceptors and their supporting target tracking facilities. Dedicated to the missions of both point and area defense, traditional systems are generally regarded as capable of modestly

fulfilling the objectives of the tactical options of preferential, layered, and threshold defense. A classic example of this type of system may be found in the now defunct SAFEGUARD ABM system [Ref. 39: pp. 198-200].

2. Simple/Novel Defense

A variety of weapons systems and technologies are currently available for simple/novel defense including conventionally armed radar or infrared homing missiles, swarms or clouds of unguided ballistic projectiles, and anti-aircraft guns. Two proposed simple/novel defensive concepts are reviewed here: the radar directed GAU-8 30mm minicannon and the SWARMJET system. Both of these systems are well suited for the point defense mission and, like the traditional systems meet the basic tactical considerations for strategic defense.

The General Electric GAU-8 gun represents a developed and proven weapons system readily adaptable for the point defense mission. Currently employed as an anti-tank weapon in the Fairchild A-10 attack aircraft, the GAU-8 has a three thousand round-per-minute firing rate, an effective range in excess of 8000 feet, and a kill probability of over 90 percent against a warhead-sized target at that range. RV destruction would be accomplished through a kinetic energy nonnuclear kill (NNK) [Ref. 40: p. 44].

The SWARMJET system is designed to saturate a "threat core" with swarms of small, spin-stabilized rockets accelerated to mile-per-second speed in short-interval salvos (on the order of one second) from hardened recoilless launchers. Target tracking is accomplished through triangulation by range-only radars [Refs. 41: pp. 48-51]. As is the case with the GAU-8, warhead destruction is accomplished through a kinetic energy NNK.

3. Layered Defense With Advanced Exoatmospheric Overlay and Traditional Underlay

As the name suggests, this type of system would combine the previously mentioned traditional or simple/novel components with an exoatmospheric interceptor of the HOE (Homing Overlay Experiment) variety. The composite technologies required for the overlay portion of this type of defense were successfully demonstrated at the Kwajalein Atoll in the June 11 1984 Project Homing Overlay Experiment (HOE) [Ref. 42: p. 41].

In the HOE flight, a Minuteman ICBM was equipped with a sophisticated IR sensor and 15 foot expanding metal mesh net designed to "snare" the target, an ICBM launched from Vandenberg AFB situated more than 4800 miles away from the Kwajalein Atoll [Ref. 42: p. 41]. The result was a spectacular exoatmospheric NNK of the dummy reentry vehicle at a range of approximately 100 miles.

HOE type interceptors operating in conjunction with simple/novel defense systems are appropriate for both point and limited area defense missions and might be of great value in the realization of the goals of preferential, layered, and threshold defense.

4. Boost-phase and Directed-energy Defenses

Successful boost-phase interception of offensive ICBMs is widely regarded as the key to a thorough system of strategic defense [Ref. 38: p.3117]. These types of systems, however, which employ either directed-energy weaponry (i.e., chemical lasers, particle beams, hypervelocity rail guns, etc.) or more technologically "traditional" devices (high-acceleration missiles mounted on satellite "trucks"), or a combination of both involve considerable unknowns. By definition, boost-phase interception cannot fulfill the objectives of the preferential defense since the intended targets of the RVs cannot be predicted during this phase of the missile's flight [Ref. 37: p.121]. This type

of system would merge well with the tactics of layered and threshold defense, however.

Defensive systems utilizing directed-energy weapons for boost-phase intercept are essentially in their infancy. On the other hand, the proposed use of available technologies to engineer hybrid systems for boost-phase intercept has received considerable attention. Systems of this nature usually assume the following basic characteristics (with some variations).

The fundamental theme in this proposal calls for a system of satellite "trucks" equipped with relatively inexpensive high-acceleration interceptors [Ref. 40: p. 42]. These satellites would be deployed in "spread orbits" at an altitude of 250 to 350 miles to form a continuous blanket of coverage over Soviet ICBM fields [Ref. 41: p. 55]. When detection of boosting Soviet ICBMs occurs, the "trucks" begin to salvo interceptors at the rising targets, based on tracking telemetry supplied by four geosynchronous battle management satellites and ten low altitude surveillance and tracking platforms. [Ref. 43: p. 46]. These interceptors would then detonate a warhead package designed to create a debris "cloud" roughly 100 feet in diameter in the unalterable ballistic trajectory of the Soviet RVs. Impact of the RVs with the debris would cause a kinetic energy NNK.

While it is possible to ascertain the effectiveness of individual components in this type of defense, it is difficult to ascertain the utility of the entire system without an extensive program of testing and evaluation under realistic operational conditions. This same sort of dilemma also holds true for systems employing advanced directed energy devices.

5. Dust Defense

Dust defense is the least technologically sophisticated system of BMD. In this system, high-yield nuclear

weapons are buried north of U.S. ICBM silo fields (the most likely line of approach for incoming Soviet ICBM RVs) and are detonated after receipt of positive notification of an impending attack. The detonation of these devices raises large quantities of dust and debris in the path of the incoming warheads and destroys them through erosion of the RV's heatshield.

Systems of this type are well suited for the point defense mission and are highly advantageous in terms of technological simplicity. In addition, these systems are capable of nearly total attrition of an approaching RV "wave" with minimal weapon and targeting requirements. However, the implications of an accidental detonation due to a false alarm and the inadequacies of this system for urban area defense are obvious [Ref. 35: pp. 90-91].

V. A MEASURE OF EFFECTIVENESS FOR STRATEGIC DEFENSE

A. OVERVIEW

The research presented thus far demonstrates the centrality of the concept of deterrence and the preeminence of the countervailing strategy in declaratory U.S. strategic nuclear policy. In addition, the preceding chapters underscore the importance of U.S. strategic nuclear forces in fulfilling these objectives as well as the increasing vulnerability of these forces--particularly the ICBM leg of the TRIAD--to burgeoning Soviet nuclear might. In light of these and other previously discussed considerations, employment of strategic defenses designed primarily to enhance the deterrence process by increasing SNF survivability may clearly be construed as a viable option for the United States.

Taken separately, these concepts suffice as qualitative inputs in the formulation of measures of effectiveness for strategic defenses. Quantitative inputs, on the other hand, arrive from an evaluation of the degree of effectiveness U.S. strategic forces are expected to maintain in a nuclear exchange with the Soviet Union. This knowledge permits the analyst to determine the minimum required survivable force levels which strategic defense must guarantee in order to effectively implement the nuclear war plans of the United States.

Planning documents which prescribe the actual usage of U.S. SNF in a nuclear exchange, such as the Single Integrated Operational Plan (SIOP) or Nuclear Weapons Employment Policy (NUWEP) provide the best source of data for this type of analysis. However, due to the unclassified nature of this thesis, the level of quantitative precision attainable from an examination of these documents cannot be

achieved. Nevertheless, open source literature and "sanitized" official political documents applicable to strategic nuclear force employment policies exist in sufficient quantity to facilitate a reasonable approximation of U.S. nuclear exchange objectives.

B. U. S. TARGETING CONSIDERATIONS

Friedberg [Ref. 8: p.572] notes that a "persistent interest" in the targeting of Soviet military installations, including hardened ICBM silos, command and control bunkers and nuclear weapons storage facilities, is reflected in the policy statements of Department of Defense officials from 1974 to the present. January 17 1974, however, represents a watershed in the evolution of U.S. nuclear employment policies. On that date, President Richard Nixon signed National Security Decision Memorandum (NSDM)-242, a document promulgating "a new national guidance for strategic employment policy . . . and the incorporation of greater flexibility into the U.S. nuclear posture" (emphasis added). [Ref. 25: p.621] NSDM-242 also empowered Secretary of Defense James Schlesinger to develop the NUWEP, a document designed to fulfill the political mandate for greater strategic flexibility stipulated by NSDM-242 [Ref. 25: p.622]. The "greater flexibility" was to be achieved through the development of sets of selected targeting options for the SIOP and SIOP forces.

Inputs to the target base for the SIOP and SIOP forces are managed primarily by the National Strategic Target List Division (NSTLD) of the Joint Strategic Target Planning Staff (JSTPS). Prior to the so-called "Schlesinger shift" of early 1974, the national strategic target list (NSTL) consisted of approximately 25,000 potential targets. By 1980, the increased emphasis on flexibility through selected targeting options embodied in NSDM-242 had caused the NSTL to expand to nearly 40,000 potential target installations

[Ref. 44: p.108]. According to testimony provided to the Senate Armed Services Committee by the Department of Defense in 1980 [Ref. 45: p.2721], the 40,000 target installations are divided into five general categories:

(1) War supporting industry:

- Ammunition factories.
- Tank and armored personnel carrier factories.
- Petroleum refineries.
- Railway yards and repair facilities.

(2) Industry that contributes to economic recovery:

- Coal.
- Basic Steel.
- Basic aluminum
- Cement.
- Electric Power.

(3) Conventional military forces:

- Kasernes..
- Supply depots.
- Marshalling points.
- Conventional airfields.
- Ammunition storage facilities.
- Tank and vehicle storage yards.

(4) Nuclear forces:

- ICBM/IRBM(Intermediate Range Ballistic Missiles) LF's (Launch Facilities) and LCC's
- Nuclear weapon storage sites.
- Long range aviation bases (nuclear capable aircraft).
- SSBN bases.

(5) Command and control:

- Command posts.
- Key communications facilities.

Of the preceding categories, the two which contain the bulk of significantly hardened (i.e., greater than 2000 psi resiliency) Soviet military assets are the nuclear forces and command and control target sets. In the event of a nuclear exchange, U.S. planning requirements dictate the prompt destruction of these target sets be achieved by retaliatory U.S. SNF to preclude the possibility of either a counterforce or countervalue oriented Soviet second strike. The destruction of war supporting industries, industries contributing to economic reconstitution and conventional military forces, while significant in its own right, nevertheless does not constitute a time-urgent target set. The issue then becomes one of how best to apply the components of the strategic TRIAD to fulfill the flexible targeting objectives against Soviet nuclear forces and command and control facilities delineated in the NUWEP and the SIOP.

C. AN MOE FOR ICBM SURVIVABILITY

Chapter II demonstrated that at the present, the land-based ICBM components of U.S. SNF represent the best mechanism for achieving prompt hard target kills based on the characteristics and capabilities of these weapons systems. Submarine launched ballistic missiles are adequate as far as time-urgency considerations are concerned but have only a limited HTK capability. In the case of strategic bombers, the criteria of time-urgency and HTK capability are essentially the reverse of SLBMs, and the issue of successful penetration of hostile airspace arises.

However, Chapter III illustrated the increasing vulnerability of the U.S. ICBM force to a preemptive Soviet first strike. While it is true that a significant number of at-sea SLBM warheads remain in the scenario depicted in Table IX, these warheads would be of dubious utility in the conduct of effective retaliatory strikes against target sets (4) and (5). This is a result of the overall performance of U.S.

SLBM systems against 1000 psi (and greater) targets (See Table III). Since target sets (4) and (5) are truly time-urgent in character, the possible use of strategic bombers against these categories does not even warrant consideration in this discussion due to the long transit times associated with these platforms. A two-fold question must therefore be addressed: What portion(s) of target sets (4) and (5) necessitate the exclusive use of U.S. ICBMs, and what are the total warhead requirements to effect the destruction of these targets.

Two criteria will be used in evaluating a potential target set as warranting the expenditure of a U.S. HTK ICBM warhead. The first is essentially a technical requirement; the target should be hardened to withstand blast overpressures of a sufficiently high level which only an ICBM warhead can obviate. A target resiliency of 2000 psi or greater will be used in the target designation process. Second, and most importantly, the target should represent a significant Soviet military asset which unless promptly destroyed by a U.S. ICBM warhead, would contribute a great deal to a Soviet second strike capability.

In the category of Soviet nuclear forces, the ICBM silos and their associated LCCs clearly qualify as a prompt counterforce target set for the U.S. ICBM force, utilizing the previously defined criteria. Intermediate range ballistic missiles(i.e., SS-20) and their associated launch facilities are generally mobile, lightly armored systems and are therefore susceptible to greatly reduced blast overpressures. Although nuclear weapons storage sites would no doubt be significantly hardened and would represent a sizeable reload capability for the SS-17 and SS-18 systems (a total of 458 silos) they do not constitute a particularly time-urgent target set suitable for U.S. ICBM warhead expenditure. A recent large-scale reload exercise of SS-18 silos indicated

that from two to five days are required to complete this type of evolution [Ref. 46: pp. 14-15]. Additionally, while long range Soviet aviation bases supporting nuclear capable aircraft are time-urgent targets, they are unlikely potential targets for HTK ICBM warheads due to the inherent vulnerability of most aircraft to blast overpressures in excess of 3 psi [Ref. 47: p. 29]. Soviet SSBN support facilities would also not be considered as potential U.S. ICBM target sets as the majority of the structures at these bases and pier-side submarines are not likely to withstand blast overpressures exceeding the 500 to 1000 psi range. With the exception of the highly resilient Soviet ICBM and LCC network then, the balance of the nuclear forces target category would be best suited for targeting by the non-ICBM forces of the TRIAD.

The category of Soviet command and control facilities contains a mix of target sets which could conceivably require utilization of HTK ICBM warheads by the United States. For example, as early as 1977 the Soviets were known to have constructed underground command and control centers for the political and military leadership in the metropolitan Moscow area capable of withstanding 1000 psi blast overpressures [Ref. 48: p. 42]. In the same year, a report issued by the U.S. Arms Control and Disarmament Agency (ACDA) acknowledged that the Soviets had also constructed a multitude of command and communications facilities which are hardened to over 600 psi of blast overpressure [Ref. 49: pp. 18-20]. It is reasonable to suggest that the Soviets have improved these facilities in the time which has elapsed since the information in the ACDA report was made public.

Admittedly, these facilities approach the 2000 psi blast overpressure criteria and might legitimately be construed in some cases as potential U.S. ICBM targets. Furthermore, these target sets are decidedly important to the Soviet

Union for nuclear battle management. However, it is highly likely that these assets would essentially be rendered impotent by the destruction of the military centerpiece essential to the achievement of Soviet nuclear warfighting objectives: namely, the ICBMs of the Soviet Strategic Rocket Forces (SRF). Therefore, it is suggested that the category of command and control is best suited for targeting by the non-ICBM SIOP forces of the United States.

In sum, the target category truly warranting the prompt expenditure of ICBM warheads in a retaliatory U.S. second strike consists of Soviet ICBM silos and launch control centers. Currently, this target set consists of 1398 silos and 300 launch control centers distributed in 28 "fields" throughout the Soviet Union [Ref. 44: p. 108]. These figures, however, comprise a pre-exchange hard target set for U.S. ICBM warhead employment.

If the Soviets were to utilize roughly 210 HTK ICBMs in a preliminary counterforce strike against U.S. SNF (See Table VII), this target set would be reduced to 1190 ICBM silos and 260 "threat" LCCs (values rounded to nearest ten). The reduction in the silo target base is obtained simply by subtracting the "fired" Soviet ICBM systems from the pre-attack figure. The attrition of the pre-attack LCC value of 300 by 40 units is based on an assumption that Soviet LCCs manage silos at a uniform rate of 300 to 1400, or approximately one LCC for every five ICBMs. At this rate, the firing of 210 silos would eliminate nearly 40 units from the pool of "threat" launch control centers.

Based on the preceding analysis, a revised total of 1450 (1190 plus 260) hardened installations warranting the expenditure of U.S. ICBM HTK warheads is obtained. Assuming U.S. targeting objectives stipulate the assignment of a single, reliable warhead to each of these facilities, a minimum of seventy percent of the 2100 warhead Minuteman

force would be required to effectively negate the second strike capability embodied in the "new" Soviet nuclear force target base (Titan IIs deleted for simplicity). A given assumption throughout this analysis is the presence of a sufficiently robust U.S. command, control, communications and intelligence (C3I) network able to rapidly ascertain the location of these installations and disseminate retargeting data to the surviving Minuteman force.

However, the Minuteman force remaining at the termination of the Soviet counterforce strike depicted in Table VII is only capable of mustering 274 available (not necessarily reliable) HTK warheads. These 270-odd warheads would be capable of targeting a mere eighteen percent of the remaining 1450 Soviet ICBMs and LCCs. It is arguably certain that even if these surviving U.S. warheads should manage to destroy a full 18 percent of the revised nuclear forces target set, the Soviets could still field somewhere in the neighborhood of one thousand ICBMs, assuming an equitable destruction of both ICBMs and LCCs was achieved by the residual Minuteman force.

The issue then becomes one of how to fill a gap of nearly fifty percent between U.S. targeting objectives and the realities of the post-attack ICBM force disposition depicted in Table IX. An obvious solution would be the employment of active strategic defenses to make up the deficit between U.S. strategic intentions and capabilities. Based on these and other considerations presented in the preceding paragraphs, a system of strategic defense designed to enhance the deterrence process by reducing the vulnerability of U.S. SNF should, as a minimum, be capable of ensuring the survival of seventy percent of the ICBM leg of the strategic TRIAD. The translation of U.S. strategic targeting objectives into a quantified value for ICBM survivability represents a valid measure of effectiveness for a system of strategic defense.

D. A HYPOTHETICAL SYSTEM OF STRATEGIC DEFENSE

Chapter IV examined the fundamental concepts, systems, and technologies associated with strategic defense. Particularly noteworthy are the concepts of layered defense with advanced exoatmospheric overlay and traditional underlay, and the simple/novel defense systems. These concepts merit further study for three reasons.

First, the technologies employed in these types of strategic defenses are, for the most part, rapidly maturing (i.e., the HOE-type interceptor) if not actually available "off the shelf" (i.e., the GAU-8 cannon). Second, layered defenses obviate the need to seek high levels of performance at each individual layer of the system. Additionally, layered defenses reduce the ability of the offense to countermeasure the entire system and enhance the capability of the defense to overcome countermeasures due to the multiplicity of defensive weapons and sensors employed in the process. Finally, these types of systems are generally regarded as being well suited to the point defense of U.S. ICBM silos and LCCs.

The hypothetical system of strategic defense envisaged in this section consists of a layered defense with advanced exoatmospheric overlay and a simple/novel defense underlay. Two considerations justify the substitution of simple/novel defenses in place of the traditional system underlay. The first is the proven technological feasibility of point/novel defenses. Although the systems architecture presented here emphasizes point/novel defenses in the generic sense, testing and evaluation of candidate underlay systems such as the GAU-8 has yielded impressively high performance values suggesting an excellent technological disposition to the role of point defense [Ref. 40: p. 44.]. The second consideration is the attainment of mathematical simplicity in the probabilistic modeling used to evaluate the performance of a

layered system of strategic defense. Because the effective ranges of point/novel defenses are several orders of magnitude less than those of the advanced exoatmospheric overlay (i.e., 1.3nm for the GAU-8 as opposed to 100nm for HOE-type interceptors), simultaneous interception of a Soviet warhead by the underlay and the overlay may be regarded as mutually exclusive probabilistic events. This greatly simplifies the modeling process used in the evaluation of this type of strategic defense.

Suppose the United States were to develop and deploy strategic defenses conforming to the systems architecture described above at each of the potential targets listed in Table VII. Assume further that operational testing and evaluation programs have demonstrated a warhead kill probability of .7 for each type of platform used in both the overlay and underlay networks. In addition, the defenses located at each potential target site possess sufficient logistic robustness and tactical responsiveness to effectively engage up to six warheads per designated target in rapid sequence. This assumption is based on a uniform distribution of over 6000 Soviet HTK ICBM warheads (Table IV) among approximately 1000 hardened U.S. military targets in an all-out Soviet counterforce strike as opposed to the "partial" strike depicted in Table VII. Furthermore, assume that the defensive network is optimally deployed in a geographic sense to facilitate a layered defense of U.S. ICBMs and LCCs plus the strategic bomber and SSBN support bases. Again, the presumption of a survivable C3I network is applied. An evaluation of this particular system of strategic defense follows.

1. Evaluating the Hypothetical System.

The probability that an attacking Soviet warhead is destroyed by either an advanced exoatmospheric overlay or a simple/novel underlay (but not both) is determined by the following equation [Ref. 31: p. 24]:

$$P(O \cap U) = P(O) + P(U) - P(O \cup U). \quad (\text{eqn 5.1})$$

In equation (5.1) the variables O and U represent the probability of achieving warhead kill by the overlay and underlay systems, respectively. Substitution of the values of .7 for both O and U in the above equation yields an overall warhead kill probability of .91 for the layered system of strategic defenses described in the preceding section.

By using the methodology for determining the expected value of a discrete random variable [Ref. 17: p. 125], it is possible to merge this value with the Soviet counterforce scenario in Chapter III (Table VII) to arrive at a revised disposition of post-attack U.S. SNF. The results are presented in the following table, which includes undefended post-attack disposition data (Table IX) and percent improvement in SNF survivability for purpose of comparison.

TABLE XI
POST ATTACK COMPOSITION OF U. S. SNF (DEFENDED)

Target	Pre-attack	Post-attack (defended)	Post-attack (undefended)	% chng.
ICBM LCCs	133	110	17	70
Titan II	33	27	4	70
Minuteman II	450	372	59	70
Minuteman III (Mk-12)	250	206	98	43
Minuteman III (Mk-12A)	300	248	117	43
SSBN BASES	3	1	0	33
SAC BASES	16	12	1	69

Notes:

(a) Values rounded down to nearest whole number.

A cursory examination of the revised data in Table IX clearly indicates the dramatic improvement in post-attack U.S. ICBM force levels. The employment of a layered system of strategic defenses to protect U.S. SNF produced a new total of 1734 available Minuteman warheads for use in second strike counterforce targeting scenarios. This is equivalent to 82 percent of the pre-attack Minuteman force levels. In addition, strategic bomber survivability has been increased to the 75 percent level. However, the preservation of the SSBN support facilities leaves a great deal to be desired.

E. SUMMARY

The most important conclusion to be derived from this chapter is obvious: Utilization of a layered system of strategic defense drastically improves the survivability of the ICBM leg of the strategic TRIAD. The hypothetical systems architecture evaluated in this section exceeded the MOE of 70 percent ICBM survivability by better than ten percent. Furthermore, significant gains in U.S. second strike counterforce potential were achieved through the partial improvements in the survivability of strategic bomber bases and SSBN support facilities. The importance of enhanced U.S. ICBM survivability, however, cannot be overemphasized. Research presented in this and previous chapters clearly underscores the national need for maintaining a viable second strike ICBM force in order to fulfill U.S. strategic targeting objectives of effectively negating a Soviet second strike capability. Strategic defenses provide the necessary means to achieve this given end.

A second observation also warrants brief mention here. The methodology used in the development and evaluation of a hypothetical system of strategic defense enjoys equal validity for alternative systems architectures utilizing advanced technologies (i.e., directed-energy weapons) and additional layering (i.e., more than two). It is reasonable

to suggest that the augmentation of a layered system of exoatmospheric overlay with point/novel underlay by a system of boost-phase defenses using maturing technologies would likely yield even greater improvements in U.S. strategic nuclear force survivability.

VI. SUMMARY CONCLUSIONS

A. RESEARCH RESULTS AND RECOMMENDATIONS

Seven basic conclusions and recommendations which may be derived from the research presented in this work warrant reiteration in this brief summary chapter. The ordering sequence of these observations is chronological in nature.

First, the fundamental strategic objective of the United States is the deterrence of Soviet aggressions which could conceivably escalate to a large-scale nuclear confrontation between the superpowers. The validity of this notion may be substantiated through a careful examination of the official declaratory posture statements of the U.S. political leadership over a period spanning two decades. The centrality of deterrence theory to the U.S. strategic planning process is likely to enjoy viability well into the immediate future.

Second, the strategic paradigm through which the United States nurtures the deterrence process is not one of mutually assured vulnerability through the prospect of massive societal punishment, nor is it one of a prevailing strategy. Contrary to popular perceptions within a sizeable portion of the intellectual community, the mechanism through which the U.S. effectively deters the Soviet Union is that of the countervailing strategy. This paradigm emphasizes the thwarting or denial of Soviet objectives across the spectrum of conflict. It is decidedly not one of indiscriminate destruction of the Soviet populace or the imposition of military and political victory in the classical sense--two attributes identified respectively with the mutual assured vulnerability and prevailing strategy schools of deterrent thought.

Furthermore, an examination of the strategic doctrine of the Soviet Union substantiates the hypothesis that the

Soviets do not adhere to the paradigm of mutually assured vulnerability. The literature of the field unequivocally suggests a complete rejection of the mutual restraint and assured vulnerability associated with the assured destructionist school of deterrent thought prevalent among the Western defense intellectual community. The political and military leadership of the Soviet Union regard the deterrence process as a means of diminishing the probability of a U.S. initiated nuclear conflict while simultaneously facilitating a paralysis of the Western Alliance to resist future Soviet expansionism. If any Western paradigm of deterrence is applicable to the strategic intent of the Soviet Union it would clearly be one of the prevailing strategy with its requisite emphasis on military and political victory.

Fourth, the strategic nuclear forces of both the Soviet Union and the United States are representative of the what is perceived as viable means for achieving the stated objectives of the declaratory policies of the two superpowers. However, an examination of the countermilitary potential of the SNF of both nations indicates that the Soviets possess significant leverage in terms of hard target kill ICBM weaponry. This Soviet capability may be legitimately construed as an effective tool for fulfilling the prevailing strategic approach to nuclear war-fighting frequently posited in Soviet literature. What is particularly disquieting though, is the increasing vulnerability and accompanying reduced countermilitary potential of U.S. SNF due to burgeoning Soviet ICBM capabilities. This situation poses increasingly serious challenges to the U.S. strategic nuclear capability mandatory for the fulfillment of stated political objectives of achieving deterrence through a countervailing strategy.

The fifth observation concerns the increasing vulnerability of the U.S. ICBM force to growing Soviet HTK capabilities as demonstrated with the hypothetical Soviet first

strike scenario depicted in Chapter IV. The disposition of post-attack U.S. SNF are clearly inadequate for the execution of the counterforce second strike targeting requirements stipulated in the same chapter. Resolution of this scenario was reduced to three alternatives: complete capitulation, indiscriminate spasm countervalue strikes with residual U.S. SIOP forces, or the utilization of strategic defenses to reduce Soviet incentives for preemption by revitalizing the survivability of the U.S. deterrent force. In light of U.S. strategic targeting considerations in a counterforce second strike, a measure of effectiveness for a deterrence enhancing system of strategic defense was determined to be preservation of seventy percent of pre-attack U.S. ICBM force levels.

Sixth, the methodology of measures of effectiveness provides a useful tool in assessing the utility of alternative approaches for achieving the strategic objectives of the United States. In the area of strategic defense, the greatly simplified strawman concept developed and evaluated in this thesis represents the utilization of the measures of effectiveness methodology at a most basic level. Nevertheless, the basic principles of goal identification, quantifiability and the ability to measure to what degree the stated goal is achieved requisite with the MOE process require the analyst to focus attention where it matters the most.

Finally, the entirety of this work is offered as evidence to support the recommendation that serious consideration be given to the development and deployment of a system of strategic defense fundamentally consistent with the hypothetical architecture examined in this work as expeditiously as possible. The continued vitality of the deterrence process dictates nothing less.

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